

## **Cost of Compliance with NO<sub>x</sub> Emissions Standards for Fossil-Fired Electric Power Generation by 2007**

### **Dennis Smith**

U.S. Department of Energy, Federal Energy Technology Center, 626 Cochrans Mill Road, Pittsburgh, PA 15236

### **Alfred Mann and Massood Ramezan**

Burns and Roe Services Corporation, 1501 Wallace Road, Library, PA 15129

### **Jon Ward**

Science Applications International Corporation, 1710 Goodridge Drive, McLean, VA 22102

### **Summary**

To achieve a more stringent ambient-air ozone standard promulgated in 1997 under Title I of the Clean Air Act Amendments, the U.S. Environmental Protection Agency (EPA) has established the nitrogen oxides (NO<sub>x</sub>) State Implementation Plan (SIP) Call rule, promulgated on September 24, 1998. This rule sets summer ozone season (May 1 to September 30) NO<sub>x</sub> budgets for states in the SIP Call region, comprising 22 eastern and midwestern states and the District of Columbia. The sources on which EPA based the state NO<sub>x</sub> budgets consists of large electricity generating units, industrial boilers and combustion turbines, stationary internal combustion engines, and cement manufacturing operations. As a class, the electricity generating units are the largest source of NO<sub>x</sub> emissions in EPA's analysis, with 1757 units identified as being affected by the SIP Call.

The U.S. Department of Energy's Federal Energy Technology Center (FETC) has performed a compliance cost analysis for utility and non-utility power plants burning fossil fuels (coal, oil, and gas) in the SIP Call region. It is assumed that the affected units will have set up, by January 1, 2000, the necessary combustion modifications for Title IV compliance (principally low-NO<sub>x</sub> burners). Growth rates for power production, provided by EPA, are used to estimate NO<sub>x</sub> emissions by unit in the year 2007. Without additional controls, total seasonal NO<sub>x</sub> emissions from the affected sources in 2007 is projected to be about 1.5 million tons. To meet the emissions target for the new NO<sub>x</sub> SIP Call rule of 544,000 tons, additional controls for these fossil-fired units would require an overall 64% reduction capability, or 958,000 tons of NO<sub>x</sub>, during the summer ozone season.

The FETC analysis focuses on two commercially demonstrated technologies for NO<sub>x</sub> control: selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR). Other technologies and possible future advances in SCR and SNCR technologies are not considered in this study. The modeling strategy incrementally adds the selected technologies in the most cost effective manner to the population of 1757 affected units.

In the analysis, about 97% of the total required NO<sub>x</sub> removal is achieved by using SCR, with the remaining 3% achieved using SNCR. The average size of the 518 units applying SCR is 345 MWe, and the average size of the 218 units applying SNCR is 109 MWe. Total capital expenditure is about \$10.6 billion, and the average cost-effectiveness is \$1,602/ton of NO<sub>x</sub> removed, based on constant 1997 dollars. Total costs are about \$1.6 billion per year, consisting of \$1.18 billion in capital charges and \$344 million in operating and maintenance costs. These economics are affected by site specific requirements and variations in technology performance.

The analysis shows that coal-fired units are the predominant candidates for NO<sub>x</sub> control technologies, accounting for 940,000 tons (98%) of total NO<sub>x</sub> reduction requirements.

In its rulemaking, EPA projected a compliance cost of \$1.4 billion per year, which is within the range of costs estimated in the FETC analysis.

Although SNCR and SCR processes are commercially available, there remain some technical and economic uncertainties because these technologies have had only limited applications to coal-fired electric utility boilers in the United States.